Sociality in lizards: family structure in free-living King's Skinks *Egernia kingii* from southwestern Australia

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ABSTRACT

King's Skinks *Egernia kingii* are large viviparous scincid lizards from southwestern Australia. Although some other species within the genus *Egernia* are known to exhibit complex sociality, with long-term associations between adults and their offspring, there are no published records of such behaviour for *E. kingii*. Ten years' observations on a single family of lizards (a pair of adults plus six successive litters of their offspring) in a coastal suburban backyard 250 km south of Perth also revealed a very stable adult pair-bond in this species. The female produced litters of 9 to 11 offspring in summer or autumn at intervals of one to three years. In their first year of life, neonates lived with the adult pair and all the lizards basked together; in later years the offspring dispersed but the central shelter-site contained representatives of up to three annual cohorts as well as the parents. Adults tolerated juveniles (especially neonates) and their presence may confer direct parental protection: on one occasion an adult skink attacked and drove away a tigersnake *Notechis scutatus* that ventured close to the family's shelter-site. Although our observations are based only on a single pair of lizards and their offspring, they provide the most detailed evidence yet available on the complex family life of these highly social lizards.

Key words: behaviour, *Egernia kingii,* lizard, parental care, reptile, Scincidae, social organisation

Introduction

The social systems of lizards have traditionally been viewed as relatively simple, typically involving either male territoriality or dominance hierarchies (Olsson 1993; Gullberg *et al.* 1997). Indeed, available data (albeit based on only a tiny fraction of the >3,000 living lizard species) suggest that such mating systems are the norm among lizards from a diverse array of phylogenetic lineages. Nonetheless, recent studies have revealed an unsuspected complexity in social systems within a few lizard species, including individual recognition of partners (Olsson and Shine 1998) or offspring (Bull *et al.* 1994), and long-term monogamy (Bull 1994, 2000; Bull *et al.* 1998). Most remarkably, some lizards live in stable aggregations of closely-related individuals (Gardner *et al.* 2001, 2002). Such aggregations may range from "nuclear families" consisting of an adult pair plus their offspring (O'Connor and Shine 2003) through to much larger assemblages containing multiple adults of both sexes plus their offspring (Stow *et al.* 2001). All of the species for which such complex sociality has been described belong to a single phylogenetic lineage ("the *Egernia* Group") comprising four genera of large viviparous Australian skinks (*Corucia, Cyclodomorphus, Egernia* and *Tiliqua*: Greer 1989).

The genus *Egernia* is of particular interest because (uniquely, so far as is known) it contains species ranging in social systems from solitary existence through to the complex aggregations described above (see review by Chapple 2003). Thus, studies on the species of this genus have enormous potential not only to expand the diversity of social systems known to be exhibited by reptiles, but also to test competing hypotheses on the evolutionary pressures responsible for social aggregation. Unfortunately, however, detailed information is available for only a small subset of taxa, mostly restricted to southeastern Australia (*E. cunninghami, E. saxatilis, E. stokesii, E. striolata*: Gardner *et al.* 2001, 2002; Stow *et al.* 2001; Chapple 2003; O'Connor and Shine 2003). For other taxa we have only limited field studies (*E. major, E. whitii*: Hickman 1960; Milton 1987, 1990; Klingenbök *et al.* 2000) or purely anecdotal reports (see Chapple 2003). Hence, we need reliable data on social organization in other *Egernia* species, especially those from different geographic areas and phylogenetic groupings. The present paper provides such data, based on long-term (>10-year) observations on a single adult pair of free-living *Egernia kingii* and their offspring.

Methods

Study species

Egernia kingii is a large (to 244 mm snout-vent length [SVL]) dark-coloured viviparous scincid lizard species widely distributed through coastal and near-coastal habitats in the southwestern corner of Western Australia (Storr *et al.* 1981). It is most abundant on offshore islands, where it is primarily herbivorous during adult life but sometimes feeds on invertebrates and seabird eggs (Storr *et al.* 1981; Arena 1986; Richards 1990; Langton 2000). The most extensive information on this species' ecology comes from an unpublished Honours thesis by Arena (1986). He reported that males and females attain similar body sizes, but males have larger heads; males attain sexual maturity at 190 mm and females at 185 mm SVL; adults maintain fixed home ranges in the field, and adult males fight each other during the mating season; females produce small litters in autumn; and juveniles may associate with the female parent for several years after birth (Arena 1986).

Study site

In 1982 one of us (CM), an amateur naturalist, moved to a newly-constructed house 300 m from the ocean in the small town of Peppermint Grove Beach, 246 km south of Perth. The surrounding habitat consists of sand dunes mostly vegetated with peppermint trees *Agonis flexuosa* with a low understorey. *Egernia kingii* were seen intermittently, but in 1991 a pile of 23 jarrah planks (mean length 3.7 m, width 20 cm; left over from fence-building) in the backyard attracted a pair of adult lizards which have lived there ever since. The pile of planks has been left undisturbed throughout this period.

Results

Beginning in January 1993, CM began taking photographs and recording sightings of the skinks. The two adults were easily distinguishable by their body sizes, their tolerance of close human approach, and because one had a regrown tail. Copulation of the two adults was observed only twice, both times near the planks, in late mornings of two consecutive days in February 2003. Cohorts of newly-born skinks have appeared in and around the pile of planks at intervals of one to three years since 1993, in summer or early autumn (Table 1). The neonates were always first discovered when basking with their parents on the planks, and were never seen anywhere else in the garden throughout their first year of life. The group of adults plus offspring living in the pile of planks typically basked communally (often, in physical contact with each other) rather than separately in time or space (Fig. 1). In March 2003, for the first time, we saw the two adults basking with three generations of their offspring (one animal only slightly smaller than the adults; four about half their size; and five in their first year of life).

Year	Month	Number of offspring
1993	January	11
1996	January	11
1998	January	10
1999	January	9
2001	February	9
2002	March	9

Table 1. Reproductive output of a pair of free-living King's Skinks. The lizards produced only six litters over a ten-year period. The Table shows the month the neonates were first seen (almost certainly within a few days of their birth) and the number of offspring in each litter.

The numbers of offspring fell significantly over the first several months of life, so that by the spring following their birth there were generally about three to five surviving offspring. Juveniles of different ages are readily distinguished by their body sizes, and typically during summer the two adults shared their shelter site with one or two generations of their offspring. In the second and subsequent years of the offspring's life they were sometimes seen in other parts of the garden. The tendency for larger offspring to disperse may relate to agonistic behaviour whereby both adults sometimes chased and bit their larger progeny. All of these encounters that we saw occurred in parts of the garden away from the central shelter site. However, the adult skinks tolerated smaller offspring, and did not retaliate even when youngsters took pieces of food protruding from the adults' mouths.

We have not observed predation nor found carcasses of skinks within the backyard. However, the lizards responded rapidly to birds flying overhead, with the smaller skinks fleeing first while the adults often remained in place on their basking sites. The skinks showed no overt reaction to bobtail lizards *Tiliqua rugosa* that occasionally moved through the backyard but we witnessed one vigorous interaction with another reptile species in April 1999. The larger adult *E. kingii* was found entwined, and rolling over and over with, a tigersnake *Notechis scutatus* only slightly longer than itself. When the two reptiles separated, the snake fled with the skink in hot pursuit. The skink later reappeared with no overt injuries.

Discussion

Although our observations concern only a single adult pair of lizards, living in the modified habitat of a suburban garden, they nonetheless provide by far the most detailed information yet available on the social system of *Egernia kingii*. Despite the fact that these large lizards are a spectacular and sometimes abundant component of the fauna of southwestern Australia, they remain virtually unstudied by scientists. Various facets of their biology have been described in Honours theses (Arena 1986; Jones 1988; Richards 1990; Langton 2000), but all are as yet unpublished. One paper by German reptile-keepers summarises limited field data and observations of captive specimens (Hauschild and Gassner 1994).

We have no genetic evidence that the neonates we saw were the offspring of the resident adult pair, but it is very likely. No other adult *E. kingii* were seen in the backyard over the entire period of the study, and copulation between the two adults was observed. Thus, although we do not know which was the male and which the female, we can be confident that the "pair" contained one adult of each sex. Molecular analyses of parentage in other *Egernia* species have revealed occasional cases of multiple paternity of litters, but long-term monogamy is common (Gardner *et al.* 2001, 2002; Stow *et al.* 2001; O'Connor and Shine 2003).

Litter sizes recorded in our study (9 to 11: Table 1) were larger than those generally reported for *E. kingii* ("usually two" in Bush *et al.* 1995; "2–9 young" in Hauschild and Gassner 1994; "2–8" in Arena 1986; Greer 1989). This difference may simply reflect the large body size of our

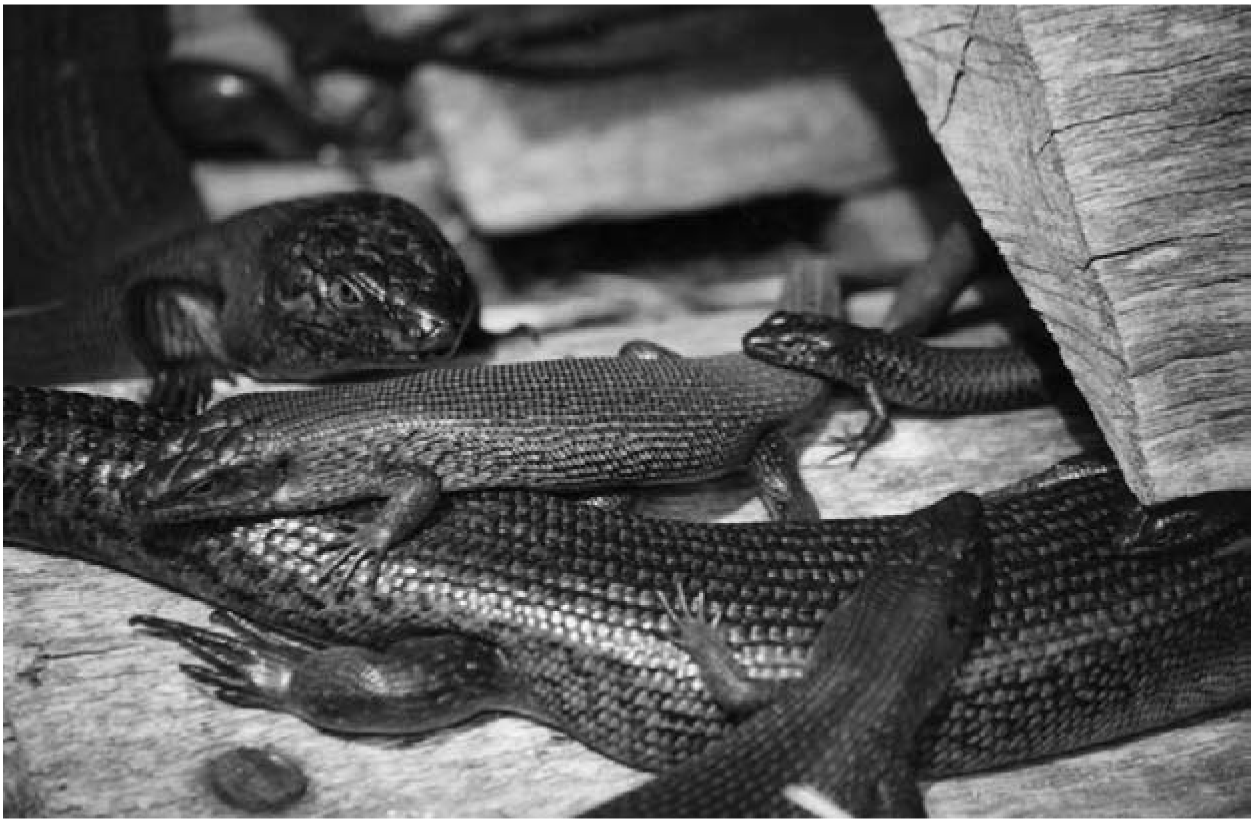

Figure 1. Communal basking in a family group of free-living King's Skinks, *Egernia kingii,* in a suburban backyard in southwestern Australia. Photograph by Lesley Jackes.

female; in most lizard species, larger females produce larger litters (Greer 1989). The intermittent nature of reproduction is also of interest, with the intervals between successive litters ranging from one to three years (Table 1). Less-than-annual reproduction is common in reptiles, especially viviparous species inhabiting relatively cool climates (Bull and Shine 1979).

The only detailed published information on sociality in *E. kingii* consists of a Table entry in Gardner (1999) noting that "juveniles coexist with parents until they reach sexual maturity at approximately three years of age", based on personal communication. This estimate is consistent with our own data, as are more general statements (e.g. "usually found living in colony groups" - Bush *et al.* 1995). It also fits well with recent studies on other (eastern Australian) *Egernia* species, revealing complex social systems based around long-term associations between adult lizards and their offspring. Indeed, the genus *Egernia* provides the only well-documented cases of such complex sociality in squamate reptiles (Chapple 2003).

Unfortunately, available data are too sparse to compare the social system of *E. kingii* with that of congeneric species. Some *Egernia* species live mostly in "nuclear families" of two adults plus their offspring (*E. saxatilis* - O'Connor and Shine 2003) whereas others live in much larger groups of closely related individuals (*E. cunninghami* - Stow *et al.* 2001; *E. stokesii* - Gardner *et al.* 2001, 2002). However, we do not yet know the extent of geographic (habitat-associated?) variation in social systems within any single species. Based on the single adult pair that we studied, the social system of *E. kingii* may be intermediate between the two extremes outlined above. Considerable variation is apparent in many behaviours: for example, both *E. stokesii* and *E. cunninghami* groups tend to retreat en masse into crevices when danger threatens (Eifler 2001; Lanham 2001), whereas in our lizards it was usually only the juveniles that retreated.

The observation of an adult *E. kingii* fighting a tigersnake is particularly interesting. The snake was too large for the lizard to ingest (indeed, adult *E. kingii* are primarily herbivorous: Richards 1990) and the lizard was too large for the snake to ingest. The obvious inference is that this behaviour constituted direct parental protection of offspring (which were ingestible-sized for such a snake, and would be acceptable prey for this snake species: Shine 1987). We are unaware of any previous example of such behaviour in lizards or snakes, apart from an increase in aggressive responses to an intruder by postpartum rattlesnakes (Shine 1988; Graves 1989; Greene *et al.* 2002; see also anecdotal reports for other viperid snakes summarised by Greene *et al.* 2002).

Our study demonstrates yet again the potential contribution that can be made by amateur naturalists to our understanding of the Australian fauna (Greer 1989). This country has an extraordinary biological diversity but only a very small number of professional scientists to conduct ecological and behavioural research on wildlife. The inevitable result is that our only hope of obtaining information on a broad cross-section of the Australian fauna is through cooperative endeavours between naturalists and scientists. The complex family life of King's Skink provides an extraordinary example of the kind of phenomenon that awaits discovery through patient observation.

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